PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-135497

(43)Date of publication of application : 13.05.2003

(51)Int.Cl. A61F 2/48
A61F 2/02
A61M 1/10

(21)Application number : 2001-340804

(22)Date of filing : 06.11.2001

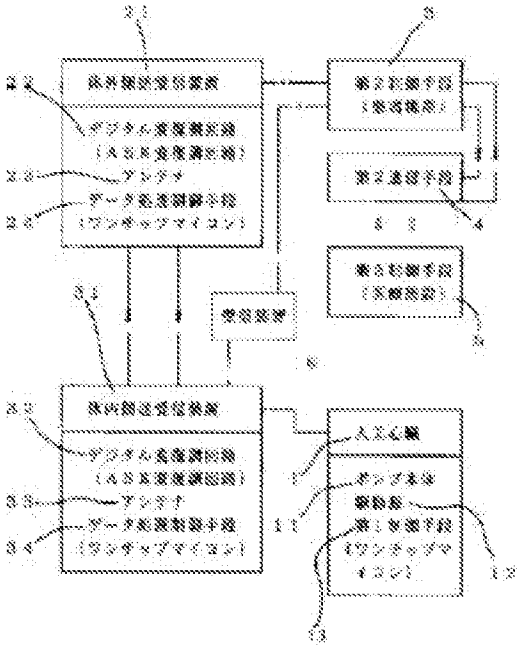
(71)Applicant : MIWATEC:KK
OKAMOTO EIJI

(72)Inventor : OKAMOTO EIJI

(54) PERCUTANEOUS INFORMATION TRANSMITTING SYSTEM FOR ARTIFICIAL ORGAN OR THE LIKE

(57)Abstract:

PROBLEM TO BE SOLVED: To secure the safe and proper operation of an artificial organ, etc., by correctly and bi-directionally transmitting information concerning the operation control of the artificial organ, etc., at high speed and also fairly preventing the runaway and mulfunction, etc., of a computer which constitutes the control means of a system.



SOLUTION: The system includes a first control means for controlling the operation of the artificial organ embedded in a living body, a second control means which is placed outside of the living body and exchanges information with the first control means, and a first transmitting means for performing percutaneous (without invading the living body) transmission of an information signal between the first and second control means. A first communication means consists of an external transmitter/receiver and an internal transmitter/receiver which mutually exchange the signal by electromagnetic induction. The both transmitters/receivers respectively have a digital modulating/ demodulating circuit and a data processing control means. Thus, the artificial organ is normally and fairly operated at high speed by an accurate data processing and bi-directional transmission in the percutaneous information transmitting system for the

artificial organ, etc.

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]An endermic information transmission system in an artificial organ etc. which is provided with the following and characterized by enabling it to always operate said artificial organ properly by processing of high-speed and exact data and bidirectional transmission.
The 1st control means that makes motion control of an artificial organ laid underground in the living body.
The 2nd control means that is out of a living body, and delivers and receives information between said 1st control means.
Have the 1st transmission means that transmits an information signal between said 1st control means and the 2nd control means endermically (without carrying out invasion of the living body), and said 1st means of communication, Constituting from outside-of-the-body side transceiving equipment which transmits and receives a signal mutually by electromagnetic induction, and inside-of-the-body side transceiving equipment, both this transceiving equipment is a digital modulation and demodulation circuit and a data processing controlling means, respectively.

[Claim 2]Claim 1 comprising:
The 3rd control means that delivers and receives information between the 2nd control means.
The 2nd means of communication that transmits an information signal between said 2nd control means and the 3rd control means with radio system.

[Claim 3]An endermic information transmission system in an artificial organ etc. which are characterized by the 2nd means of communication being what can transmit and receive mass data in a high speed and both directions with radio system in Claim 2.
[Claim 4]An endermic information transmission system in an artificial organ etc. which are

characterized by the 2nd means of communication being what can be connected to computer networks, such as the Internet, in Claim 3.
[Claim 5]The 1st control means, the 2nd control means, and a data processing controlling means consist of one-chip microcomputers, respectively.
while making as [communicate / communication available distance of the 1st means of communication is around about 7 cm, and / on the other hand, / with inside-of-the-body side transceiving equipment / it / via clothes] -- being concerned -- others -- an endermic information transmission system in an artificial organ preventing interference with an endermic information transmission system.

[Claim 6]An endermic information transmission system in an artificial organ etc. which are characterized by forming a receiving set of an information signal from inside-of-the-body side transceiving equipment, replacing with outside-of-the-body side transceiving equipment further in one of Claims 1-5, and enabling it to monitor an operation situation of an artificial organ in the 2nd control means.
[Claim 7]An endermic information transmission system in an artificial organ etc. which are characterized by an artificial organ being either an artificial heart or an artificial pancreas in one of Claims 1-6.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]The invention in this application relates to the endermic information transmission system which transmits control information to the control means of an artificial organ if needed based on the variety of information noninvasively transmitted to the outside of the body from an artificial organ in the living body.
[0002]
[Description of the Prior Art]In order to transmit a variety of information to an artificial heart, an artificial pancreas (insulin pump), other artificial organs, or various measuring machine machines in the living body etc. which were embedded in the living body and to control from the outside of the body, the research which uses a near infrared ray or electromagnetic waves is made as a transmission means of an information signal. When using a near infrared ray, the distance which can penetrate and transmit the skin is short in it being about 1 cm, and various problems produce it. since [namely,] the signal transmission through clothes is difficult and needs to arrange the transceiving equipment by the side of the inside of the body in a hypodermic shallow position -- for example, this transceiving equipment and artificial heart equipment (a pump.) The inconvenience of **, such as necessity, has an inescapable imperfect alignment prevention means between the transceiving equipment by the side of the inside of the body and the outside of the body which must set up a channel between a driving means and a drive control means.
[0003]On the other hand, the trial which communicates by electromagnetic waves between the inside of the body and the outside of the body has stopped at transmission of low frequency wave analog signals, such as an electrocardiogram, blood pressure, body temperature. On the other hand, it is possible to compute a momentary artificial heart ejection flow, blood pressure, etc. from instant motor current and the degree of instant motor rotational angle, and to make

the motion control of an artificial heart more precisely for example, in a motor drive artificial heart, based on these various data, in order to realize this, mass information can be transmitted and received between the in-the-living-body-outside of the body at high speed and exactly -- required -- things -- it becomes. It is expected that such necessity will increase further from now on. That is, it is because I will develop increasingly the function of an artificial heart, a defibrillator, an artificial pancreas, and other artificial cochlea and inside-of-the-body embedding type apparatus, I will exchange much more information between the in-the-living-body-outside of the body and control with high accuracy corresponding to an advanced function will be needed. In exchange of a living body's predetermined region, for example, the information signal between a muscular part of a certain kind and source of motion control of this (brain), it will realize further again in the future when it is also near to change to an information transmission system peculiar to a living body, or to transmit an information signal with this, and to control necessary. Also in this case, it is indispensable that mass information can be transmitted and received between the in-the-living-body-outside of the body at high speed and exactly.

[0004]

[Summary of Invention]The 1st control means that makes the motion control of the artificial organ laid underground in the living body in an endermic information transmission system [in / in the invention in this application / an artificial organ etc.], The 2nd control means that is out of a living body, and delivers and receives information between said 1st control means, Have the 1st transmission means that transmits the information signal between said 1st control means and the 2nd control means endermically (without carrying out invasion of the living body), and said 1st means of communication, With the outside-of-the-body side transceiving equipment which transmits and receives a signal mutually by electromagnetic induction, and inside-of-the-body side transceiving equipment, constitute and both this transceiving equipment, As it has a digital modulation and demodulation circuit and a data processing controlling means, respectively and said artificial organ can always be properly operated by processing of high-speed and exact data and bidirectional transmission, it is going to solve above-mentioned conventional SUBJECT.

[0005]In the above-mentioned composition, it may have the 3rd control means that delivers and receives information between the 2nd control means, and the 2nd means of communication that transmits the information signal between said 2nd control means and the 3rd control means with radio system.

[0006]In the above-mentioned composition, the 2nd means of communication may be made with the composition which can transmit and receive mass data in a high speed and both directions with radio system.

[0007]In said composition, it can connect with computer networks, such as the Internet, and

the 2nd means of communication may be constituted.
[0008]The 1st control means, the 2nd control means, and a data processing controlling means consist of one-chip microcomputers further again, respectively.
while making as [communicate / the communication available distance of the 1st means of communication is around about 7 cm, and / on the other hand, / with inside-of-the-body side transceiving equipment / it / via clothes] -- being concerned -- others -- it may make with the composition of preventing interference with a system.

[0009]And further, in any of the above, or the system of a description, the receiving set of the information signal from inside-of-the-body side transceiving equipment may be formed, and it may make as [monitor / in the 2nd control means / it replaces with outside-of-the-body side transceiving equipment, and / the operation situation of an artificial heart].
[0010]Furthermore in the above, an artificial organ may consist of other artificial cochlea and inside-of-the-body embedding type artificial hearts, defibrillators, artificial pancreases, or apparatus.
[0011]
[Embodiment of the Invention]Hereafter, the embodiment of the invention in this application is described. Drawing 1 is a block diagram showing the related composition of each element in one embodiment of the invention in this application. The artificial heart is used as an artificial organ laid under the inside of the body by this embodiment. In the figure, 1 is an artificial heart embedded thoroughly inside of the body, and is provided with the 1st control means that controls an artificial heart via a pump body, the motor as a driving source, and a driving source like the after-mentioned. 2 is the 1st means of communication that intervenes between the 1st control means and the 2nd control means 3 in the outside of the body.
The information between said both control means is transmitted with the radio system by electromagnetic waves.
4 is the 2nd means of communication that intervenes between the 2nd control means 3 and the 3rd control means 5.
The information between said both control means is transmitted with the radio system by electromagnetic waves.
As this 2nd means of communication 4, although various communication configurations can be used, by this embodiment, what is called PHS that is a personal handy phone system is adopted. This PHS fits high-speed data transmission.
There are little electric wave and influence which it has on medical equipment even if it uses it in medical facilities, such as a hospital, since it is weak.
The system which connects with computer networks, such as the Internet, via a wired telephone line as other communication configurations is also effective. And 6 is a receiving set

of reception only, receives the information signal from the below-mentioned inside-of-the-body side transceiving equipment in the 1st means of communication 2, and monitors the operation situation of an artificial heart in the 2nd control means.

[0012]Said 2nd control means 3 is a computer which the wearing person of an artificial heart can carry, and has a function which monitors the transfer of information and the operation situation of an artificial heart which start the drive of an artificial heart between the 1st control means in the artificial heart 1.

[0013]Said 3rd control means 5 is what processes the various information fed back from the 1st control means while sending out control information to the 1st control means in the artificial heart by the side of the inside of the body via said 2nd control means 3, It is always installed in a hospital and other medical facilities, and comprises a host computer under a medical practitioner's etc. management. This 3rd control means 5 is added to the steady control action of the 2nd control means 3, Or when the state of starting an artificial heart exceeds the controllability of the 2nd control means 3, the 2nd control means 3 is replaced, and if the drive controlling of an artificial heart is made and required, necessary directions information will be transmitted to the wearing person itself via the 2nd control means (monitoring screen etc.).

[0014]Drawing 2 explains further. Drawing 2 is a block diagram of the artificial heart system centering on the related composition of the component of the 1st means of communication 2 and the artificial heart 1. The artificial heart 1 is provided with the 1st control means 13 concerning the pump body 11, the electric motor 12 as a driving source of this pump body 11, and control of a driving source.

[0015]Said 1st control means 13 comprises a one-chip microcomputer of 16-bit capacity, an encoder, etc. at this embodiment.

The drive controlling information transmitted from said 2nd and 3rd control is processed, and operation of the electric motor 12 as a driving source is controlled.

This 1st control means 13 monitors operation of the electric motor 12, and sends out the information about that angle of rotation and current to said 2nd and 3rd control means. Said 2nd control means 3 or the 3rd control means 5 carries out the presumed grasp of the living body hemodynamics, such as blood pressure and a blood-flow situation, based on the information fed back from the 1st control means 13, and sends thereby still more nearly required control information to the 1st control means 13.

[0016]Said 1st means of communication 2 comprises the outside-of-the-body side transceiving equipment 21 and the inside-of-the-body side transceiving equipment 31 laid underground in the living body. The outside-of-the-body side transceiving equipment 21 is provided with the one-chip-microcomputer 24 grade with a capacity of about 16 bits as the ASK modulation and demodulation circuit 22 as a digital modulation demodulator circuit, the transmitting antennas 23, and a data processing controlling means. The inside-of-the-body side transceiving

equipment 31 is also the same composition as the outside-of-the-body side transceiving equipment 21, and is provided with the one-chip-microcomputer 34 grade with a capacity of about 16 bits as the ASK modulation and demodulation circuit 32 as a digital modulation demodulator circuit, the transmitting antennas 33, and a data processing controlling means.
[0017]By the in the living body burial and outside-of-the-body side, the light-gage mold coil is being used for the transmitting antennas 23 and 33 in consideration of the wearing nature to the body at the inside-of-the-body side. Although it becomes so good [the coupling coefficient of the coil between transmission and reception] that a coil diameter becomes large, the embedding fitness to a living body, etc. are spoiled. For this reason, the transmission coil was formed in the diameter of 40 mm by the enameled wire of 0.4 mm of wire sizes, and 1.5-mm thickness from the result of measurement comparison of a coil synthesis coefficient on various conditions at this embodiment. And it was considered as the form which fits in the receiver coil formed on the concentric shaft inside this transmission coil at the diameter of 20 mm by the enameled wire of 0.2 mm of wire sizes, and 1.5-mm thickness.
[0018]The control system of the 1st control means 13 grade of the inside-of-the-body side transceiving equipment 31 and the artificial heart 1 is formed in the shape of a card type in consideration of the embedding fitness to a living body. That is, while electronic parts, such as a one-chip microcomputer which constitutes said data processing controlling means 34 and the 1st control means 13, are carried on a predetermined substrate, said transmission and reception coil is laid under the slot engraved on the substrate, pre-insulation is carried out by the well-known means, and it forms in card shape.
[0019]it not having the necessity for shape[of a card type]-izing as mentioned above, since the outside-of-the-body side transceiving equipment 21 does not assume the embedding to a living body, but, taking the wearing nature to clothes into consideration on the other hand, -- as much as possible -- thin meat -- packing to a small thing is desirable.
[0020]Although an information signal will be conveyed by the outside-of-the-body side transceiving equipment 21, the inside-of-the-body side transceiving equipment 31, and electromagnetic waves, it is necessary to take into consideration various conditions also including the characteristic of an artificial heart about selection of the frequency. That is, if frequency is set to not less than tens of MHz, it must take into consideration that neither the influence of the electromagnetic wave absorbing of a body tissue appearing nor floating capacitance can be disregarded, but alignment becomes difficult, that interference prevention is required, etc. So, in this embodiment, the clock and subcarrier of said one-chip microcomputer were made to share, and carrier frequency was chosen by one-chip-microcomputer operation clock frequency within the limits. As a result, while the carrier frequency from 4 MHz and the outside of the body to the inside of the body was 10 MHz the carrier frequency from the inside of the body to the outside of the body, it could transmit and

receive simultaneously, without a bidirectional signal wave interfering mutually by using the high tuned circuit of Q showing the sharpness of a frequency characteristic. As for the output of the outside-of-the-body side transceiving equipment 21 and the inside-of-the-body side transceiving equipment 31, it is desirable for communication available distance to set it as about 7 cm because of the interference prevention between the artificial heart systems concerning the invention in this application. There is no trouble in communication of the outside-of-the-body side transceiving equipment 21 with which it equipped on clothes when communication available distance was about 7 cm, and the inside-of-the-body side transceiving equipment 31, and if interference with other systems is also an anticipated-use mode, it will not produce.

[0021]Said receiving set 6 is for receiving the information signal from the inside-of-the-body side transceiving equipment 31, for example at the time of a patient's bathing, etc., when the outside-of-the-body side transceiving equipment 21 cannot be used. The receiving sets 6 differ in the outside-of-the-body side transceiving equipment 21, clothes are equipped with them, and it does not communicate, and since it will be used near the patient, placing, the ready-for-receiving ability range requires about 2m. The performance information of an artificial heart will be sent to said 2nd control means 3 from the inside-of-the-body side transceiving equipment 31 via this receiving set 6, and monitoring of an artificial heart will be made.

[0022]An operation of this embodiment is explained based on the above-mentioned composition. Predetermined control information is transmitted to the 1st control means 13 in the artificial heart 1 via the 1st means of communication 2, and the 1st control means 13 operates the motor 12 which is a driving source of the pump body 11 by a prescribed condition by this control information.

On the other hand, performance information, such as a momentary current value in the motor 12 and instant angle of rotation, is transmitted to the 2nd control means 3 via the 1st means of communication 2.

The 2nd control means 3 computes a momentary artificial heart ejection flow, blood pressure, etc. by processing of said performance information, and checks the driving state of the pump body 11. When it can be judged with said computed value that the drive of the pump body 11 is made under setups, the driving state is maintained.

[0023]on the other hand, when said computed value has separated from setups, based on the reform information stored beforehand, the 2nd control means 3 transmits the new control information about the drive boiled motor 12 to the 1st control means. As a result, when said computed value is judged to have returned to the specified value, the pump body 11 maintains that driving state. When said computed value does not return to setups by new control information, That is, for the reform information beforehand stored in the 2nd control means 3, when it is judged that the situation is not improvable, it requires transmission of the new control

information for a situation improvement while notifying the 3rd control means in medical facilities, such as a hospital, of the 2nd control means 3.

[0024]Transmission of the above-mentioned variety of information is made by the 1st means of communication 2 and the 2nd means of communication 4. After predetermined data processing was made in the one-chip microcomputer as the data processing controlling means 24 of the outside-of-the-body side transceiving equipment [in / first / in the information transmitted to the 1st control means 13 / the 1st means of communication 2] 21 from the 2nd control means 3, After being conveyed by electromagnetic induction and making the same data processing as the above in the one-chip microcomputer as the data processing controlling means 34 to the inside-of-the-body side transceiving equipment 31, it is sent to the 1st control means 13 in the artificial heart 1, and predetermined motion control is made about the motor 12. And the information on the 2nd control means 3 from the 1st control means 13 is also transmitted through a course contrary to the above.

[0025]In said course of information transmission, it sets to each data processing controlling means 24 and 34 of the outside-of-the-body side transceiving equipment 21 and the inside-of-the-body side transceiving equipment 31. Error judgment of transmitted and received data and correction processing are made. That is, for example, it is incorporated into the one-chip microcomputer 24 of the outside-of-the-body side transceiving equipment 21, error judgment of data and correction processing are made, and the information signal from the 2nd control means 3 is transmitted to the inside-of-the-body side transceiving equipment 31 via a wearing person's body tissue by electromagnetic induction after ASK modulation. In the inside-of-the-body side transceiving equipment 31, the receipt information after an ASK recovery is incorporated into the one-chip microcomputer 34 like said outside-of-the-body side, and error judgment of data and correction processing are made. When there is no error, it is outputted to the 1st control means 13 of the artificial heart 1 as it is. Data has an error, when it can correct, it is corrected and outputted, but when it is a data error whose error correction is impossible, it notifies the transmitting side that the data transmission error occurred, and resending of data is made. The abnormal occurrence in said both control means will be prevented by transmitting a signal to the 1st control means 13 and the 2nd control means 3, and closing a communication circuit by the error judging process of a carrier signal, when it is judged that the communication state by the side of the inside-of-the-body side-inside of the body has a certain trouble.

[0026]Since this embodiment arranges a control means (microcomputer) as mentioned above to both the transceiving equipment by the side of the outside of the body of the 1st means of communication, and the inside of the body and the error and correction processing of transmitted and received data are performed within the 1st means of communication, Fear of malfunction generating is also very small, without [therefore] an overload taking for the computer which constitutes the 2nd control means that functions as the 1st control means in

the artificial heart 1, or a monitoring means by the side of a patient also at the time of data high-speed transmission. In addition to the above-mentioned operation effect, it becomes easy to miniaturize it, in order that the control system by the side of the inside of the body may also take the composition which distributes the control means by a microcomputer (communication, drive controlling).

[0027]The 2nd control means that performs usual drive controlling and the surveillance of a driving state per artificial heart, Since it is remotely supported by the 3rd control means with the host computer in which medical professionals participate via the 3rd means of communication of a public radio telephone network, an Internet communication network, etc., various situations which may be generated in an artificial heart can be coped with properly.

[0028]

[Effect of the Invention]Since the invention in this application has the composition operation explained above, it can acquire the following effects.

(1) the information concerning motion control, such as an artificial organ, can be correctly transmitted in high-speed both directions -- safety, such as an artificial organ, -- suitable operation is securable.

(2) generating of a reckless run of the computer which constitutes the control means of a system, malfunction, etc. can be prevented properly -- safety, such as an artificial organ, -- suitable operation is securable.

(3) Since in addition to steady drive controlling, such as an artificial organ, and surveillance the necessary directions to an artificial organ wearing person can be transmitted at any time if needed while being able to make a still more advanced control action remotely, largely ** to the security of the patient especially outside medical facilities. Since various information is collectable from an artificial organ etc., the further progress of the related iatrotechnique is also expectable.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL FIELD

[Field of the Invention]The invention in this application relates to the endermic information transmission system which transmits control information to the control means of an artificial organ if needed based on the variety of information noninvasively transmitted to the outside of the body from an artificial organ in the living body.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EFFECT OF THE INVENTION

[Effect of the Invention]Since the invention in this application has the composition operation explained above, it can acquire the following effects.
(1) the information concerning motion control, such as an artificial organ, can be correctly transmitted in high-speed both directions -- safety, such as an artificial organ, -- suitable operation is securable.
(2) generating of a reckless run of the computer which constitutes the control means of a system, malfunction, etc. can be prevented properly -- safety, such as an artificial organ, -- suitable operation is securable.
(3) Since in addition to steady drive controlling, such as an artificial organ, and surveillance the necessary directions to an artificial organ wearing person can be transmitted at any time if needed while being able to make a still more advanced control action remotely, largely ** to the security of the patient especially outside medical facilities. Since various information is collectable from an artificial organ etc., the further progress of the related iatrotechnique is also expectable.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL PROBLEM

[Description of the Prior Art]In order to transmit a variety of information to an artificial heart, an artificial pancreas (insulin pump), other artificial organs, or various measuring machine machines in the living body etc. which were embedded in the living body and to control from the outside of the body, the research which uses a near infrared ray or electromagnetic waves is made as a transmission means of an information signal. When using a near infrared ray, the distance which can penetrate and transmit the skin is short in it being about 1 cm, and various problems produce it. That is, since the signal transmission through clothes is difficult and needs to arrange the transceiving equipment by the side of the inside of the body in a hypodermic shallow position, they are for example, this transceiving equipment and artificial heart equipment.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

MEANS

The inconvenience of **, such as necessity, has an inescapable imperfect alignment prevention means between the transceiving equipment by the side of the inside of the body and the outside of the body which must set up a channel between (a pump, a driving means, and a drive control means).
[0003]On the other hand, the trial which communicates by electromagnetic waves between the inside of the body and the outside of the body has stopped at transmission of low frequency wave analog signals, such as an electrocardiogram, blood pressure, body temperature. On the other hand, it is possible to compute a momentary artificial heart ejection flow, blood pressure, etc. from instant motor current and the degree of instant motor rotational angle, and to make the motion control of an artificial heart more precisely for example, in a motor drive artificial heart, based on these various data, in order to realize this, mass information can be transmitted and received between the in-the-living-body-outside of the body at high speed and exactly -- required -- things -- it becomes. It is expected that such necessity will increase further from now on. That is, it is because I will develop increasingly the function of an artificial heart, a defibrillator, an artificial pancreas, and other artificial cochlea and inside-of-the-body embedding type apparatus, I will exchange much more information between the in-the-living-body-outside of the body and control with high accuracy corresponding to an advanced function will be needed. In exchange of a living body's predetermined region, for example, the information signal between a muscular part of a certain kind and source of motion control of this (brain), it will realize further again in the future when it is also near to change to an information transmission system peculiar to a living body, or to transmit an information signal with this, and to control necessary. Also in this case, it is indispensable that mass information can be transmitted and received between the in-the-living-body-outside of the body at high speed and exactly.
[0004]

[Summary of Invention]The 1st control means that makes the motion control of the artificial organ laid underground in the living body in an endermic information transmission system [in / in the invention in this application / an artificial organ etc.], The 2nd control means that is out of a living body, and delivers and receives information between said 1st control means, Have the 1st transmission means that transmits the information signal between said 1st control means and the 2nd control means endermically (without carrying out invasion of the living body), and said 1st means of communication, With the outside-of-the-body side transceiving equipment which transmits and receives a signal mutually by electromagnetic induction, and inside-of-the-body side transceiving equipment, constitute and both this transceiving equipment, As it has a digital modulation and demodulation circuit and a data processing controlling means, respectively and said artificial organ can always be properly operated by processing of high-speed and exact data and bidirectional transmission, it is going to solve above-mentioned conventional SUBJECT.

[0005]In the above-mentioned composition, it may have the 3rd control means that delivers and receives information between the 2nd control means, and the 2nd means of communication that transmits the information signal between said 2nd control means and the 3rd control means with radio system.

[0006]In the above-mentioned composition, the 2nd means of communication may be made with the composition which can transmit and receive mass data in a high speed and both directions with radio system.

[0007]In said composition, it can connect with computer networks, such as the Internet, and the 2nd means of communication may be constituted.

[0008]The 1st control means, the 2nd control means, and a data processing controlling means consist of one-chip microcomputers further again, respectively.

while making as [communicate / communication available distance of the 1st means of communication is around about 7 cm, and / on the other hand, / with inside-of-the-body side transceiving equipment / it / via clothes] -- being concerned -- others -- it may make with composition of preventing interference with a system.

[0009]And further, in any of the above, or a system of a description, a receiving set of an information signal from inside-of-the-body side transceiving equipment may be formed, and it may make as [monitor / in the 2nd control means / it replaces with outside-of-the-body side transceiving equipment, and / an operation situation of an artificial heart].

[0010]Furthermore in the above, an artificial organ may consist of other artificial cochlea and inside-of-the-body embedding type artificial hearts, defibrillators, artificial pancreases, or apparatus.

[0011]

[Embodiment of the Invention]Hereafter, the embodiment of the invention in this application is described. Drawing 1 is a block diagram showing the related composition of each element in one embodiment of the invention in this application. The artificial heart is used as an artificial organ laid under the inside of the body by this embodiment. In the figure, 1 is an artificial heart embedded thoroughly inside of the body, and is provided with the 1st control means that controls an artificial heart via a pump body, the motor as a driving source, and a driving source like the after-mentioned. 2 is the 1st means of communication that intervenes between the 1st control means and the 2nd control means 3 in the outside of the body.

The information between said both control means is transmitted with the radio system by electromagnetic waves.

4 is the 2nd means of communication that intervenes between the 2nd control means 3 and the 3rd control means 5.

The information between said both control means is transmitted with the radio system by electromagnetic waves.

As this 2nd means of communication 4, although various communication configurations can be used, by this embodiment, what is called PHS that is a personal handy phone system is adopted. This PHS fits high-speed data transmission.

There are little electric wave and influence which it has on medical equipment even if it uses it in medical facilities, such as a hospital, since it is weak.

The system which connects with computer networks, such as the Internet, via a wired telephone line as other communication configurations is also effective. And 6 is a receiving set of reception only, receives the information signal from the below-mentioned inside-of-the-body side transceiving equipment in the 1st means of communication 2, and monitors the operation situation of an artificial heart in the 2nd control means.

[0012]Said 2nd control means 3 is a computer which the wearing person of an artificial heart can carry, and has a function which monitors the transfer of information and the operation situation of an artificial heart which start the drive of an artificial heart between the 1st control means in the artificial heart 1.

[0013]Said 3rd control means 5 is what processes the various information fed back from the 1st control means while sending out control information to the 1st control means in the artificial heart by the side of the inside of the body via said 2nd control means 3, It is always installed in a hospital and other medical facilities, and comprises a host computer under a medical practitioner's etc. management. This 3rd control means 5 is added to the steady control action of the 2nd control means 3, Or when the state of starting an artificial heart exceeds the controllability of the 2nd control means 3, the 2nd control means 3 is replaced, and if the drive controlling of an artificial heart is made and required, necessary directions information will be transmitted to the wearing person itself via the 2nd control means (monitoring screen etc.).

[0014]Drawing 2 explains further. Drawing 2 is a block diagram of the artificial heart system centering on the related composition of the component of the 1st means of communication 2 and the artificial heart 1. The artificial heart 1 is provided with the 1st control means 13 concerning the pump body 11, the electric motor 12 as a driving source of this pump body 11, and control of a driving source.
[0015]Said 1st control means 13 comprises a one-chip microcomputer of 16-bit capacity, an encoder, etc. at this embodiment.
The drive controlling information transmitted from said 2nd and 3rd control is processed, and operation of the electric motor 12 as a driving source is controlled.
This 1st control means 13 monitors operation of the electric motor 12, and sends out the information about that angle of rotation and current to said 2nd and 3rd control means. Said 2nd control means 3 or the 3rd control means 5 carries out the presumed grasp of the living body hemodynamics, such as blood pressure and a blood-flow situation, based on the information fed back from the 1st control means 13, and sends thereby still more nearly required control information to the 1st control means 13.
[0016]Said 1st means of communication 2 comprises the outside-of-the-body side transceiving equipment 21 and the inside-of-the-body side transceiving equipment 31 laid underground in the living body. The outside-of-the-body side transceiving equipment 21 is provided with the one-chip-microcomputer 24 grade with a capacity of about 16 bits as the ASK modulation and demodulation circuit 22 as a digital modulation demodulator circuit, the transmitting antennas 23, and a data processing controlling means. The inside-of-the-body side transceiving equipment 31 is also the same composition as the outside-of-the-body side transceiving equipment 21, and is provided with the one-chip-microcomputer 34 grade with a capacity of about 16 bits as the ASK modulation and demodulation circuit 32 as a digital modulation demodulator circuit, the transmitting antennas 33, and a data processing controlling means.
[0017]By the in the living body burial and outside-of-the-body side, the light-gage mold coil is being used for the transmitting antennas 23 and 33 in consideration of the wearing nature to the body at the inside-of-the-body side. Although it becomes so good [the coupling coefficient of the coil between transmission and reception] that a coil diameter becomes large, the embedding fitness to a living body, etc. are spoiled. For this reason, the transmission coil was formed in the diameter of 40 mm by the enameled wire of 0.4 mm of wire sizes, and 1.5-mm thickness from the result of measurement comparison of a coil synthesis coefficient on various conditions at this embodiment. And it was considered as the form which fits in the receiver coil formed on the concentric shaft inside this transmission coil at the diameter of 20 mm by the enameled wire of 0.2 mm of wire sizes, and 1.5-mm thickness.
[0018]The control system of the 1st control means 13 grade of the inside-of-the-body side transceiving equipment 31 and the artificial heart 1 is formed in the shape of a card type in

consideration of the embedding fitness to a living body. That is, while electronic parts, such as a one-chip microcomputer which constitutes said data processing controlling means 34 and the 1st control means 13, are carried on a predetermined substrate, said transmission and reception coil is laid under the slot engraved on the substrate, pre-insulation is carried out by the well-known means, and it forms in card shape.

[0019]it not having the necessity for shape[of a card type]-izing as mentioned above, since the outside-of-the-body side transceiving equipment 21 does not assume the embedding to a living body, but, taking the wearing nature to clothes into consideration on the other hand, -- as much as possible -- thin meat -- packing to a small thing is desirable.

[0020]Although an information signal will be conveyed by the outside-of-the-body side transceiving equipment 21, the inside-of-the-body side transceiving equipment 31, and electromagnetic waves, it is necessary to take into consideration various conditions also including the characteristic of an artificial heart about selection of the frequency. That is, if frequency is set to not less than tens of MHz, it must take into consideration that neither the influence of the electromagnetic wave absorbing of a body tissue appearing nor floating capacitance can be disregarded, but alignment becomes difficult, that interference prevention is required, etc. So, in this embodiment, the clock and subcarrier of said one-chip microcomputer were made to share, and carrier frequency was chosen by one-chip-microcomputer operation clock frequency within the limits. As a result, while the carrier frequency from 4 MHz and the outside of the body to the inside of the body was 10 MHz the carrier frequency from the inside of the body to the outside of the body, it could transmit and receive simultaneously, without a bidirectional signal wave interfering mutually by using the high tuned circuit of Q showing the sharpness of a frequency characteristic. As for the output of the outside-of-the-body side transceiving equipment 21 and the inside-of-the-body side transceiving equipment 31, it is desirable for communication available distance to set it as about 7 cm because of the interference prevention between the artificial heart systems concerning the invention in this application. There is no trouble in communication of the outside-of-the-body side transceiving equipment 21 with which it equipped on clothes when communication available distance was about 7 cm, and the inside-of-the-body side transceiving equipment 31, and if interference with other systems is also an anticipated-use mode, it will not produce.

[0021]Said receiving set 6 is for receiving the information signal from the inside-of-the-body side transceiving equipment 31, for example at the time of a patient's bathing, etc., when the outside-of-the-body side transceiving equipment 21 cannot be used. The receiving sets 6 differ in the outside-of-the-body side transceiving equipment 21, clothes are equipped with them, and it does not communicate, and since it will be used near the patient, placing, the ready-for-receiving ability range requires about 2m. The performance information of an artificial heart will

be sent to said 2nd control means 3 from the inside-of-the-body side transceiving equipment 31 via this receiving set 6, and monitoring of an artificial heart will be made.

[0022]An operation of this embodiment is explained based on the above-mentioned composition. Predetermined control information is transmitted to the 1st control means 13 in the artificial heart 1 via the 1st means of communication 2, and the 1st control means 13 operates the motor 12 which is a driving source of the pump body 11 by a prescribed condition by this control information.

On the other hand, performance information, such as a momentary current value in the motor 12 and instant angle of rotation, is transmitted to the 2nd control means 3 via the 1st means of communication 2.

The 2nd control means 3 computes a momentary artificial heart ejection flow, blood pressure, etc. by processing of said performance information, and checks the driving state of the pump body 11. When it can be judged with said computed value that the drive of the pump body 11 is made under setups, the driving state is maintained.

[0023]on the other hand, when said computed value has separated from setups, based on the reform information stored beforehand, the 2nd control means 3 transmits the new control information about the drive boiled motor 12 to the 1st control means. As a result, when said computed value is judged to have returned to the specified value, the pump body 11 maintains that driving state. When said computed value does not return to setups by new control information, That is, for the reform information beforehand stored in the 2nd control means 3, when it is judged that the situation is not improvable, it requires transmission of the new control information for a situation improvement while notifying the 3rd control means in medical facilities, such as a hospital, of the 2nd control means 3.

[0024]Transmission of the above-mentioned variety of information is made by the 1st means of communication 2 and the 2nd means of communication 4. After predetermined data processing was made in the one-chip microcomputer as the data processing controlling means 24 of the outside-of-the-body side transceiving equipment [in / first / in the information transmitted to the 1st control means 13 / the 1st means of communication 2] 21 from the 2nd control means 3, After being conveyed by electromagnetic induction and making the same data processing as the above in the one-chip microcomputer as the data processing controlling means 34 to the inside-of-the-body side transceiving equipment 31, it is sent to the 1st control means 13 in the artificial heart 1, and predetermined motion control is made about the motor 12. And the information on the 2nd control means 3 from the 1st control means 13 is also transmitted through a course contrary to the above.

[0025]In said course of information transmission, it sets to each data processing controlling means 24 and 34 of the outside-of-the-body side transceiving equipment 21 and the inside-of-the-body side transceiving equipment 31. Error judgment of transmitted and received data and

correction processing are made. That is, for example, it is incorporated into the one-chip microcomputer 24 of the outside-of-the-body side transceiving equipment 21, error judgment of data and correction processing are made, and the information signal from the 2nd control means 3 is transmitted to the inside-of-the-body side transceiving equipment 31 via a wearing person's body tissue by electromagnetic induction after ASK modulation. In the inside-of-the-body side transceiving equipment 31, the receipt information after an ASK recovery is incorporated into the one-chip microcomputer 34 like said outside-of-the-body side, and error judgment of data and correction processing are made. When there is no error, it is outputted to the 1st control means 13 of the artificial heart 1 as it is. Data has an error, when it can correct, it is corrected and outputted, but when it is a data error whose error correction is impossible, it notifies the transmitting side that the data transmission error occurred, and resending of data is made. The abnormal occurrence in said both control means will be prevented by transmitting a signal to the 1st control means 13 and the 2nd control means 3, and closing a communication circuit by the error judging process of a carrier signal, when it is judged that the communication state by the side of the inside-of-the-body side-inside of the body has a certain trouble.

[0026]Since this embodiment arranges a control means (microcomputer) as mentioned above to both the transceiving equipment by the side of the outside of the body of the 1st means of communication, and the inside of the body and the error and correction processing of transmitted and received data are performed within the 1st means of communication, Fear of malfunction generating is also very small, without [therefore] an overload taking for the computer which constitutes the 2nd control means that functions as the 1st control means in the artificial heart 1, or a monitoring means by the side of a patient also at the time of data high-speed transmission. In addition to the above-mentioned operation effect, it becomes easy to miniaturize it, in order that the control system by the side of the inside of the body may also take the composition which distributes the control means by a microcomputer (communication, drive controlling).

[0027]The 2nd control means that performs usual drive controlling and the surveillance of a driving state per artificial heart, Since it is remotely supported by the 3rd control means with the host computer in which medical professionals participate via the 3rd means of communication of a public radio telephone network, an Internet communication network, etc., various situations which may be generated in an artificial heart can be coped with properly.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a block diagram showing the composition outline concerning one embodiment.
[Drawing 2]It is a detail view same as the above.

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報（Ａ）**　(11)特許出願公開番号
特開2003－135497
（P2003－135497A）
(43)公開日　平成15年５月13日(2003.5.13)

(51)Int.Cl.[7]	識別記号	ＦＩ		テーマコード（参考）
Ａ６１Ｆ	2/48	Ａ６１Ｆ	2/48	４Ｃ０９７
	2/02		2/02	
Ａ６１Ｍ	1/10		2/22	

審査請求　未請求　請求項の数７　ＯＬ　（全　５　頁）

(21)出願番号　特願2001－340804(P2001－340804)

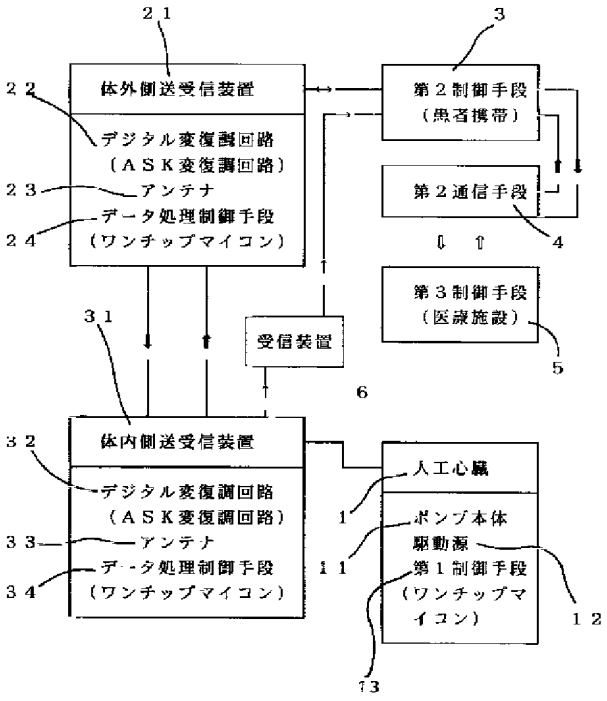
(22)出願日　平成13年11月６日(2001.11.6)

(71)出願人　593142064
株式会社ミワテック
神奈川県川崎市高津区宇奈根720番地３
(71)出願人　501431785
岡本　英治
北海道札幌市南区澄川６条13丁目１番20号
(72)発明者　岡本　英治
北海道札幌市南区澄川６条13丁目１番20号
(74)代理人　100085165
弁理士　大内　康一

Ｆターム(参考)　4C097 AA26 BB01 BB06 CC01 CC07 MM06

(54)【発明の名称】　人工臓器等における経皮的情報伝送システム。

(57)【要約】
【課題】　人工臓器等の動作制御に係る情報を高速双方向で正確に伝送でき、かつシステムの制御手段を構成するコンピュータの暴走、誤動作等の発生を適正に防止して、人工臓器等の安全適切な動作を確保する。
【解決手段】　生体内に埋設される人工臓器の動作制御をなす第１制御手段と、生体外にあって前記第１制御手段との間で情報の授受をなす第２制御手段と、前記第１制御手段と第２制御手段との間の情報信号の伝送を経皮的に（生体を侵襲することなく）なす第１伝送手段とを、具えてなり、前記第１通信手段は、電磁誘導により相互に信号の送受信をなす体外側送受信装置と体内側送受信装置とで構成し、この両送受信装置は、それぞれデジタル変復調回路とデータ処理制御手段とを有して、高速かつ的確なデータの処理および双方向伝送により前記人工臓器の動作を常時適正になし得るようにした人工臓器等における経皮的情報伝送システムの実現により課題を解決する。



【特許請求の範囲】
【請求項１】　生体内に埋設される人工臓器の動作制御をなす第１制御手段と、生体外にあって前記第１制御手段との間で情報の授受をなす第２制御手段と、前記第１制御手段と第２制御手段との間の情報信号の伝送を経皮的に（生体を侵襲することなく）なす第１伝送手段とを、具えてなり、前記第１通信手段は、電磁誘導により相互に信号の送受信をなす体外側送受信装置と体内側送受信装置とで構成し、この両送受信装置は、それぞれデジタル変復調回路とデータ処理制御手段とを有して、高速かつ的確なデータの処理および双方向伝送により前記人工臓器の動作を常時適正になし得るようにしたことを特徴とする人工臓器等における経皮的情報伝送システム。
【請求項２】　請求項１において、第２制御手段との間で情報の授受をなす第３制御手段と、前記第２制御手段と第３制御手段との間の情報信号の伝送を無線方式でなす第２通信手段とを具えたことを特徴とする人工臓器等における経皮的情報伝送システム。
【請求項３】　請求項２において、第２通信手段は無線方式で大容量のデータを高速かつ双方向で送受信できるものであることを特徴とする人工臓器等における経皮的情報伝送システム。
【請求項４】　請求項３において、第２通信手段はインターネット等のコンピュータネットワークに接続し得るものであることを特徴とする人工臓器等における経皮的情報伝送システム。
【請求項５】　第１制御手段、第２制御手段、データ処理制御手段は、それぞれワンチップマイクロコンピュータで構成する一方、第１通信手段の通信可能距離をほぼ７ｃｍ前後として、衣服を介して体内側送受信装置と通信できるようになすとともに当該他の経皮的情報伝送システムとの干渉を防止するようにしたことを特徴とする人工臓器等における経皮的情報伝送システム。
【請求項６】　請求項１ないし５いずれかにおいて、さらに、体内側送受信装置からの情報信号の受信装置を設け、体外側送受信装置に代えて第２制御手段において人工臓器の動作状況をモニタリングできるようにしたことを特徴とする人工臓器等における経皮的情報伝送システム。
【請求項７】　請求項１ないし６いずれかにおいて、人工臓器は、人工心臓または人工膵臓のいずれかであることを特徴とする人工臓器等における経皮的情報伝送システム。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本願発明は、生体内の人工臓器から体外に非侵襲的に伝送された各種情報に基づき必要に応じて人工臓器の制御手段に制御情報を伝送する経皮的情報伝送システムに関するものである。
【０００２】
【従来技術とその課題】生体内に埋め込まれた人工心臓、人工膵臓（インシュリンポンプ）その他の人工臓器あるいは各種生体内計測機器等に各種情報を送信して体外から制御するために情報信号の伝送手段として、近赤外線あるいは電磁波を用いる研究がなされている。近赤外線を用いる場合、皮膚を透過して伝送できる距離は、１ｃｍ程度でと短く、種々の問題が生じる。　すなわち、衣服を介しての信号伝送が難しい、また、体内側の送受信装置を皮下の浅い位置に配置する必要があるためこの送受信装置と例えば人工心臓装置（ポンプ、駆動手段、駆動制御手段）との間には通信路を設定しなければならない、体内側と体外側の送受信装置間での軸ずれ防止手段が必要等々、の不都合が不可避である。
【０００３】一方、体内と体外間において電磁波により通信をなす試みは、心電図や血圧、体温など低周波アナログ信号の伝送に止まっている。一方、例えばモータ駆動人工心臓等では、瞬時モータ電流と瞬時モータ回転角度から瞬時の人工心臓拍出流量や血圧等を算出しこれら各種データに基づいて人工心臓の動作制御をより精密になすことが可能であり、これを実現するためには、大容量の情報を高速かつ的確に体内－体外間で送受信できる必要ことがとなる。このような必要性は、今後さらに高まることが予想される。すなわち、人工心臓、除細動器、人工膵臓、人工内耳その他の体内埋め込み型機器の機能はますます高度化して、さらに多くの情報を体内－体外間で交換して高度な機能に対応した精度の高い制御が必要となろうからである。さらにまた、生体の所定部位例えばある種の筋肉部とこれの動作制御源（脳）との間の情報信号の交換において、生体固有の情報伝送系統に替えてまたはこれとともに、情報信号を伝送して所要の制御をなすことも近い将来において実現されるであろう。このような場合においても、大容量の情報を高速かつ的確に体内－体外間で送受信できることが不可欠である。
【０００４】
【発明の概要】本願発明は、人工臓器等における経皮的情報伝送システムを、生体内に埋設される人工臓器の動作制御をなす第１制御手段と、生体外にあって前記第１制御手段との間で情報の授受をなす第２制御手段と、前記第１制御手段と第２制御手段との間の情報信号の伝送を経皮的に（生体を侵襲することなく）なす第１伝送手段とを、具えてなり、前記第１通信手段は、電磁誘導により相互に信号の送受信をなす体外側送受信装置と体内側送受信装置とで構成し、この両送受信装置は、それぞれデジタル変復調回路とデータ処理制御手段とを有して、高速かつ的確なデータの処理および双方向伝送により前記人工臓器の動作を常時適正になし得るようにして、上記従来の課題を解決しようとするものである。
【０００５】上記構成において、第２制御手段との間で

情報の授受をなす第３制御手段と、前記第２制御手段と第３制御手段との間の情報信号の伝送を無線方式でなす第２通信手段とを具えることがある。

【０００６】さらに、上記構成において、第２通信手段は無線方式で大容量のデータを高速かつ双方向で送受信できる構成となすことがある。

【０００７】また、前記構成において、第２通信手段はインターネット等のコンピュータネットワークに接続し得るもので構成することがある。

【０００８】さらにまた、第１制御手段、第２制御手段、データ処理制御手段は、それぞれワンチップマイクロコンピュータで構成する一方、第１通信手段の通信可能距離をほぼ７ｃｍ前後として、衣服を介して体内側送受信装置と通信できるようになすとともに当該他のシステムとの干渉を防止する構成となすことがある。

【０００９】そしてさらに、上記いずれか記載のシステムにおいて、さらに、体内側送受信装置からの情報信号の受信装置を設け、体外側送受信装置に代えて第２制御手段において人工心臓の動作状況をモニタリングできるようになすことがある。

【００１０】さらに上記において、人工臓器は、人工心臓、除細動器、人工膵臓、人工内耳その他の体内埋め込み型機器のいずれかで構成することがある。

【００１１】

【発明の実施形態】以下、本願発明の実施形態を説明する。図１は、本願発明の１実施形態における各要素の関連構成を示すブロック図である。この実施形態で体内に埋設した人工臓器として人工心臓を使用している。図において、１は体内に完全に埋め込まれる人工心臓で、後述のようにポンプ本体、駆動源としてのモータ、駆動源を介して人工心臓を制御する第１制御手段を具えている。　２は、第１制御手段と体外にある第２制御手段３との間に介在する第１通信手段であり、電磁波による無線方式により前記両制御手段の間における情報の伝送をなしている。４は、第２制御手段３と第３制御手段５との間に介在する第２通信手段であり、電磁波による無線方式により前記両制御手段の間における情報の伝送をなしている。　この第２通信手段４としては、種々の通信形態を利用できるが、この実施形態では、簡易型携帯電話システムであるいわゆるＰＨＳを採用している。このＰＨＳは、高速データ通信に適しており、電波も微弱であるため病院等の医療施設で使用しても医療機器に与える影響も少ない。また、他の通信形態として、インターネット等のコンピュータネットワークに有線電話回線を介して接続する方式も有効である。そして、６は受信専用の受信装置であり、第１通信手段２における後述の体内側送受信装置からの情報信号を受信して第２制御手段において人工心臓の動作状況のモニタリングをなすものである。

【００１２】前記第２制御手段３は、人工心臓の装着者が携帯可能なコンピュータであって、人工心臓１における第１制御手段との間で人工心臓の駆動に係る情報の授受ならびに人工心臓の動作状況をモニタリングする機能を有している。

【００１３】また、前記第３制御手段５は、前記第２制御手段３を介して体内側の人工心臓における第１制御手段に制御情報を送出するとともに第１制御手段からフィードバックされる諸情報を処理するもので、常時は病院その他の医療施設に設置され、医師等の管理下にあるホストコンピュータで構成されている。この第３制御手段５は、第２制御手段３の定常的な制御動作に加えて、あるいは、人工心臓に係る状態が第２制御手段３の制御能力を超える場合には第２制御手段３に替わり、人工心臓の駆動制御をなし、要すれば装着者自身に第２制御手段（のモニター画面等で）を介して所要の指示情報を送信する。

【００１４】図２により、さらに説明する。　図２は、第１通信手段２および人工心臓１の構成要素の関連構成を中心とした人工心臓システムの構成図である。人工心臓１は、ポンプ本体１１、このポンプ本体１１の駆動源としての電動モータ１２および駆動源の制御に係る第１制御手段１３を具えている。

【００１５】前記第１制御手段１３は、本実施形態では１６ビット容量のワンチップマイクロコンピュータ、エンコーダ等から構成されており、前記第２および第３制御から伝送される駆動制御情報を処理して駆動源としての電動モータ１２の動作を制御する。また、この第１制御手段１３は、電動モータ１２の動作をモニタリングして、その回転角度、電流に関する情報を前記第２、第３制御手段に送出する。前記第２制御手段３もしくは第３制御手段５は、第１制御手段１３からフィードバックされた情報に基づき血圧、血流状況等の生体循環動態を推定把握し、これにより更に必要な制御情報を第１制御手段１３に発信する。

【００１６】前記第１通信手段２は、体外側送受信装置２１と生体内に埋設される体内側送受信装置３１とから構成されている。　体外側送受信装置２１は、デジタル変調復調回路としてのＡＳＫ変復調回路２２、送受信アンテナ２３、データ処理制御手段として容量１６ビット程度のワンチップマイクロコンピュータ２４等を具えている。また、体内側送受信装置３１も体外側送受信装置２１と同様の構成であり、デジタル変調復調回路としてのＡＳＫ変復調回路３２、送受信アンテナ３３、データ処理制御手段として容量１６ビット程度のワンチップマイクロコンピュータ３４等を具えている。

【００１７】送受信アンテナ２３、３３は、体内側では生体内への埋設、体外側では身体への装着性を考慮して、薄肉型コイルを使用している。　送受信間コイルの結合係数はコイル径が大きくなるほど良好となるが、生体への埋め込み適性等が損なわれる。　このため、種々

の条件でコイル間総合係数を測定比較の結果から、本実施形態では、送信コイルを線径０．４ｍｍのエナメル線による４０ｍｍ径、１．５ｍｍ厚に形成した。　そして、この送信コイルの内側の同心軸上に、線径０．２ｍｍのエナメル線による２０ｍｍ径、１．５ｍｍ厚に形成される受信コイルを嵌装する形態とした。

【００１８】体内側送受信装置３１と人工心臓１の第１制御手段１３等の制御系統は、生体への埋め込み適性を考慮して、カード形状に形成してある。　すなわち、所定の基板上に前記データ処理制御手段３４、第１制御手段１３を構成するワンチップマイクロコンピュータ等の電子部品を搭載する一方、基板に刻設した溝部には前記送受信コイルを埋設し、周知手段により絶縁被覆してカード状に形成する。

【００１９】一方、体外側送受信装置２１は、生体への埋め込みを想定しないから前述のようにカード形状化の必要はないが、衣服への装着性を考慮して可能な限り薄肉小型なものにパッケージすることが望ましい。

【００２０】体外側送受信装置２１と体内側送受信装置３１と電磁波により情報信号の搬送をなすことになるが、その周波数の選定については人工心臓という特性も含めて種々の条件を勘案する必要がある。すなわち、周波数が数十ＭＨｚ以上となると生体組織の電磁波吸収の影響が現れることや浮遊静電容量が無視できず同調が困難になること、干渉防止が必要なこと等を考慮しなければならない。　そこで、本実施形態では、前記ワンチップマイクロコンピュータのクロックと搬送波を共用させワンチップマイクロコンピュータ動作クロック周波数範囲内で搬送波周波数を選択した。この結果、体内から体外への搬送波周波数を４ＭＨｚ、体外から体内への搬送波周波数を１０ＭＨｚとするとともに、周波数特性の鋭さを表すＱの高い同調回路を使用することにより双方向の信号波が互いに干渉することなく同時に送受信できるようになった。なお、本願発明に係る人工心臓システム間における干渉防止のために、体外側送受信装置２１および体内側送受信装置３１の出力は、通信可能距離が７ｃｍ程度に設定することが望ましい。通信可能距離が７ｃｍ程度であれば、衣服上に装着した体外側送受信装置２１と体内側送受信装置３１の交信に支障はなく、他のシステムとの干渉も通常の使用態様であれば生じることはない。

【００２１】また、前記受信装置６は、体外側送受信装置２１を使用できない場合、例えば患者の入浴時等に体内側送受信装置３１からの情報信号を受信するためのものである。受信装置６は、体外側送受信装置２１とは異なり衣服に装着して交信をなすものではなく、患者の近傍に置いて使用することになるから受信可能範囲は２ｍ程度を要する。　この受信装置６を介して体内側送受信装置３１から人工心臓の動作情報が前記第２制御手段３に送られ人工心臓のモニタリングがなされることとなる。

【００２２】上記構成に基づいて、この実施形態の作用を説明する。所定の制御情報は、第１通信手段２を介して人工心臓１における第１制御手段１３に伝送され、この制御情報により第１制御手段１３はポンプ本体１１の駆動源であるモータ１２を所定条件で動作させる一方、モータ１２における瞬時電流値、瞬時回転角度等の動作情報を第１通信手段２を介して第２制御手段３に伝送する。　第２制御手段３は、前記動作情報の処理により瞬時の人工心臓拍出流量、血圧などを算出してポンプ本体１１の駆動状態をチェックする。前記算出値により、ポンプ本体１１の駆動が設定条件の下になされていると判断できる場合はその駆動状態を維持する。

【００２３】一方、前記算出値が設定条件を外れている場合は、予め格納されている矯正情報に基づき、第２制御手段３はモータ１２にの駆動に関する新たな制御情報を第１制御手段に伝送する。　この結果、前記算出値が所定値に戻ったと判断される場合、ポンプ本体１１はその駆動状態を維持する。　新たな制御情報によっても前記算出値が設定条件に復帰しない場合は、すなわち第２制御手段３に予め格納されている矯正情報では事態を改善できないと判断された場合、第２制御手段３は病院等の医療施設における第３制御手段に告知するとともに事態改善のための新たな制御情報の伝送を要求する。

【００２４】上記の各種情報の伝送は第１通信手段２、第２通信手段４によりなされる。第２制御手段３から第１制御手段１３へ伝送される情報はまず、第１通信手段２における体外側送受信装置２１のデータ処理制御手段２４としてのワンチップマイクロコンピュータにおいて所定のデータ処理がなされた後、体内側送受信装置３１へ電磁誘導により搬送されデータ処理制御手段３４としてのワンチップマイクロコンピュータにおいて前記と同様のデータ処理をなした後に人工心臓１における第１制御手段１３に送られ、モータ１２について所定の動作制御がなされる。そして、第１制御手段１３からの第２制御手段３への情報も前記とは逆の経路を経て伝送される。

【００２５】情報伝送の前記経路では、体外側送受信装置２１および体内側送受信装置３１の各データ処理制御手段２４、３４において　送受信データの誤り判断と訂正処理がなされる。　すなわち、例えば、第２制御手段３からの情報信号は体外側送受信装置２１のワンチップマイクロコンピュータ２４に取り込まれ、データの誤り判断と訂正処理がなされ、ＡＳＫ変調後に電磁誘導により装着者の生体組織を介して体内側送受信装置３１に送信する。体内側送受信装置３１では、前記体外側と同様にＡＳＫ復調後の受信情報がワンチップマイクロコンピュータ３４に取り込まれ、データの誤り判断と訂正処理がなされる。誤りがない場合にはそのまま人工心臓１の第１制御手段１３に出力される。データに誤りがあり、

訂正可能な場合には訂正して出力されるが、誤り訂正ができないデータエラーの場合には、送信側にデータ送信誤りが発生したことを通知してデータの再送がなされる。また、搬送波信号の誤り判断処理により、体内側－体内側の交信状態になんらかの異状があると判断される場合には、第１制御手段１３および第２制御手段３に信号を送信して通信回路を閉じることにより、前記両制御手段における異常発生を防止することになる。

【００２６】本実施形態は、上述のように第１通信手段の体外側および体内側の両送受信装置に制御手段（マイクロコンピュータ）を配置し、第１通信手段内で送受信データの誤りと訂正処理を行うので、人工心臓１における第１制御手段や患者側におけるモニタリング手段として機能する第２制御手段を構成するコンピュータにデータ高速伝送時にも過負荷がかかることなく、したがって誤動作発生の虞も極めて小さい。　また、体内側の制御系統も、マイクロコンピュータによる制御手段を分散配置（通信、駆動制御）する構成をとるため、上記の作用効果に加えて小型化が容易となる。

【００２７】さらに、人工心臓につき通例の駆動制御ならびに駆動状態の監視を実行する第２制御手段は、公衆無線電話網、インターネット通信網等の第３通信手段を介して医療専門家の関与するホストコンピュータによる第３制御手段により遠隔的にサポートされているから、人工心臓において発生し得る種々の事態に適正に対処できる。

【００２８】

【発明の効果】本願発明は、以上説明した構成作用を有するので、次のような効果を得ることができる。

（１）人工臓器等の動作制御に係る情報を高速双方向で正確に伝送でき、人工臓器等の安全適切な動作を確保できる。

（２）システムの制御手段を構成するコンピュータの暴走、誤動作等の発生を適正に防止し得て、人工臓器等の安全適切な動作を確保できる。

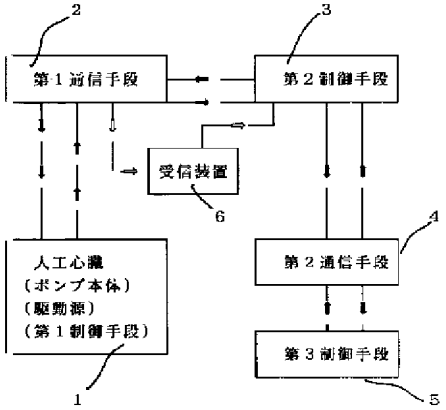
（３）人工臓器等の定常的な駆動制御、監視に加え、必要に応じて、さらに高度な制御動作を遠隔的になし得るとともに人工臓器装着者に対する所要の指示を随時伝送できるので、特に医療施設外にある患者の安全確保に資するところが大きい。　また、人工臓器等から種々の情報を収集できるので関連医療技術のさらなる進展も期待できる。

【図面の簡単な説明】

【図１】　１実施形態に係る構成概要を示すブロック図である。

【図２】　同上詳細図である。

【図１】



【図２】